

# **SAMMAMISH-WASHINGTON ANALYSIS AND MODELING PROGRAM**

## **SAMMAMISH RIVER DIURNAL DISSOLVED OXYGEN AND PH STUDY SAMPLING AND ANALYSIS PROJECT PLAN**

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**Prepared by:  
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Comprehensive Planning and Technical Resources**



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**NAME OF PROJECT:** Sammamish-Washington Analysis and Modeling Program  
(SWAMP): Sammamish River Diurnal Dissolved Oxygen and pH Study

**PROJECT NUMBER:** 423550 TASK 100

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# 1 INTRODUCTION

The Sammamish River has recently been the focus of a number of water quality studies, primarily due to the use of the river by Endangered Species Act (ESA) listed species of salmon. A review of Sammamish River monitoring data has also lead the Washington State Department of Ecology to identify water quality problems related to elevated levels of fecal coliform bacteria, temperature, and pH and reduced levels of dissolved oxygen in the river [Ecology 2000 303(d) list]. King County Department of Natural Resources and Parks (KCDNR&P) is also currently developing a hydrodynamic and water quality models of the river as part of the Sammamish-Washington Analysis and Modeling Program (SWAMP). One goal of this modeling effort is the simulation of diurnal temperature, dissolved oxygen (DO), and pH dynamics in the river.

Although continuous (15 minute to hourly interval) monitoring of temperature has been conducted at a number of locations along the river and at major tributary mouths since 1998, the current routine sampling program for dissolved oxygen and pH provides only monthly grab sample data. In order to evaluate dynamic model-predictions of DO and pH, more frequent data sampling is likely needed. Exploratory data collection conducted during the late fall of 2002 clearly indicates that relatively large diurnal fluctuations of DO and pH occur in the upper river. It is suspected that these fluctuations are driven in large part by the photosynthesis and respiration of dense beds of submerged aquatic plants that occupy much of the river channel during late summer. Therefore, data on the diurnal variation of DO and pH are needed to evaluate the significant processes that affect DO and pH levels and make quantitative comparisons between the model and field observations.

In addition to support of water quality modeling, the diurnal data will also provide data that are more suitable than the current monthly grab samples for the evaluation of river water quality.

This Sampling and Analysis Project Plan (SAPP) describes the field sampling design that is required to provide this type of data for modeling purposes. In general, it is proposed that continuous sampling for temperature, DO, and pH should be conducted at up to six locations over a 5 day period in each month from June through October. The monitoring instruments will also be configured and calibrated to measure specific conductance and possibly turbidity and/or total chlorophyll. Ideally, sampling will cover the period of greatest warming, salmonid migration, and growth of submerged aquatic plants in the river.

## 1.1 Study Area

The study area includes the Sammamish River from the Redmond Rowing Club dock to Woodinville (see Figure 1).

## 1.2 Project Background

A 2-dimensional water quality model (CE-QUAL-W2) of the Sammamish River is currently under development by KCDNR&P. The water quality model contains at least three state variables for phytoplankton that can be used to represent diatoms, green algae, and cyanobacteria. The current version of the model (version 3.1) also has a relatively simple algorithm that allows the simulation of the growth and decay of algae

attached to the river bottom and the effect of attached algal photosynthesis and respiration on DO, pH, and nutrient dynamics.

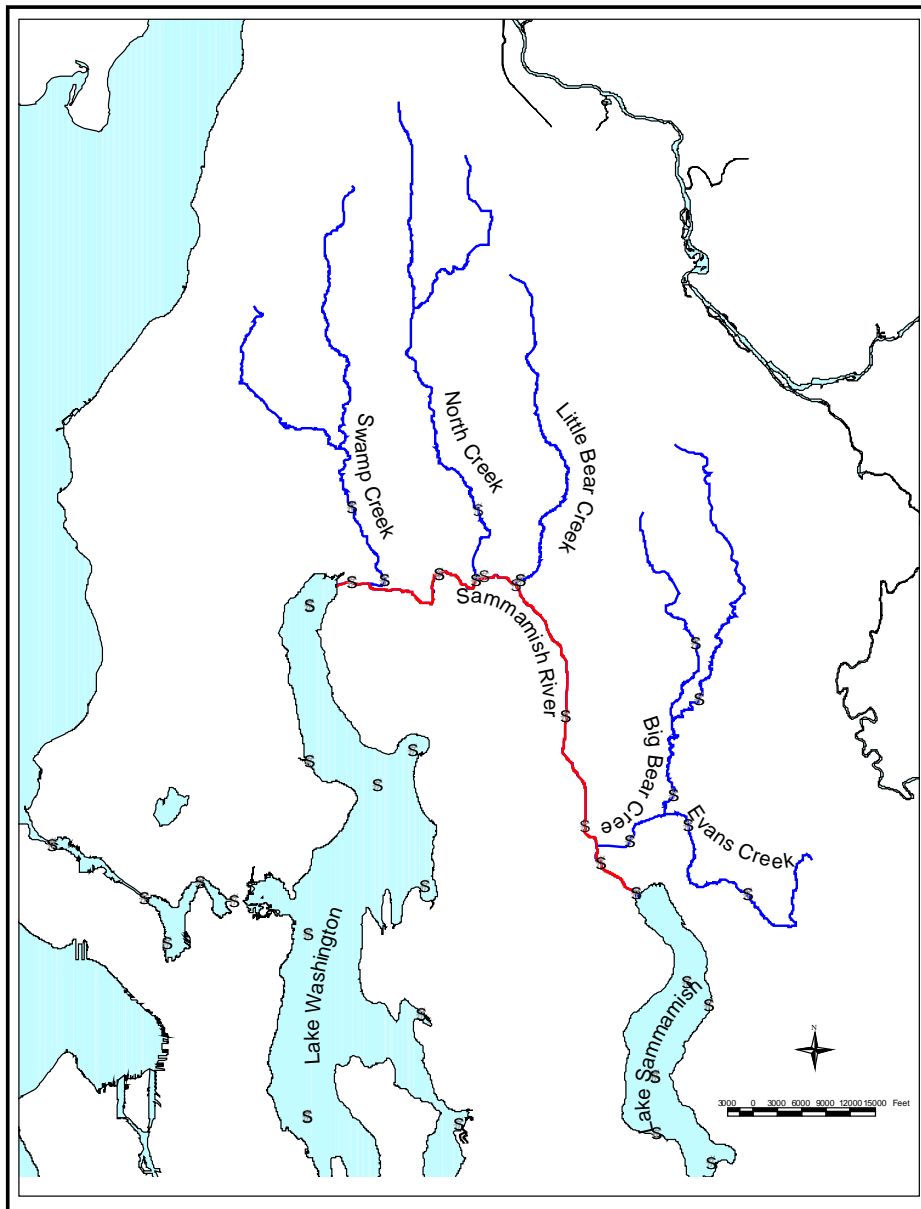


Figure 1. Study area and routine Sammamish River monitoring stations.

Current sampling of DO and pH occurs on a monthly basis. However, exploratory diurnal sampling of DO and pH in the upper reach of the Sammamish River indicates that significant variation occurs over a 24-hour period. In order to understand and model the underlying processes that result in the observed spatial and variation of DO and pH, field measurements that can resolve the diurnal variation are needed.

### 1.3 Goals and Objectives

The overall goal of this study is the collection of data that will facilitate the development and calibration of the Sammamish River water-quality model. An additional goal is to provide data for the evaluation of river water quality.

### 1.4 Historical Data Review

A limited number of diurnal DO and pH data have been collected from the Sammamish River. The first recordings were made in 2000 at the Redmond Railroad Bridge below the confluence with Big Bear Creek (Figure 2). Additional diurnal data were collected in 2002 at the Redmond Rowing Club, Redmond Railroad Bridge, 116<sup>th</sup> Bridge on the Sammamish River and on Big Bear Creek near the confluence with the Sammamish River (Figure 3).

Presently, KCDNR&P monitors DO and pH (and a number of other parameters) on a monthly basis at a number of locations along the river (Figure 1).

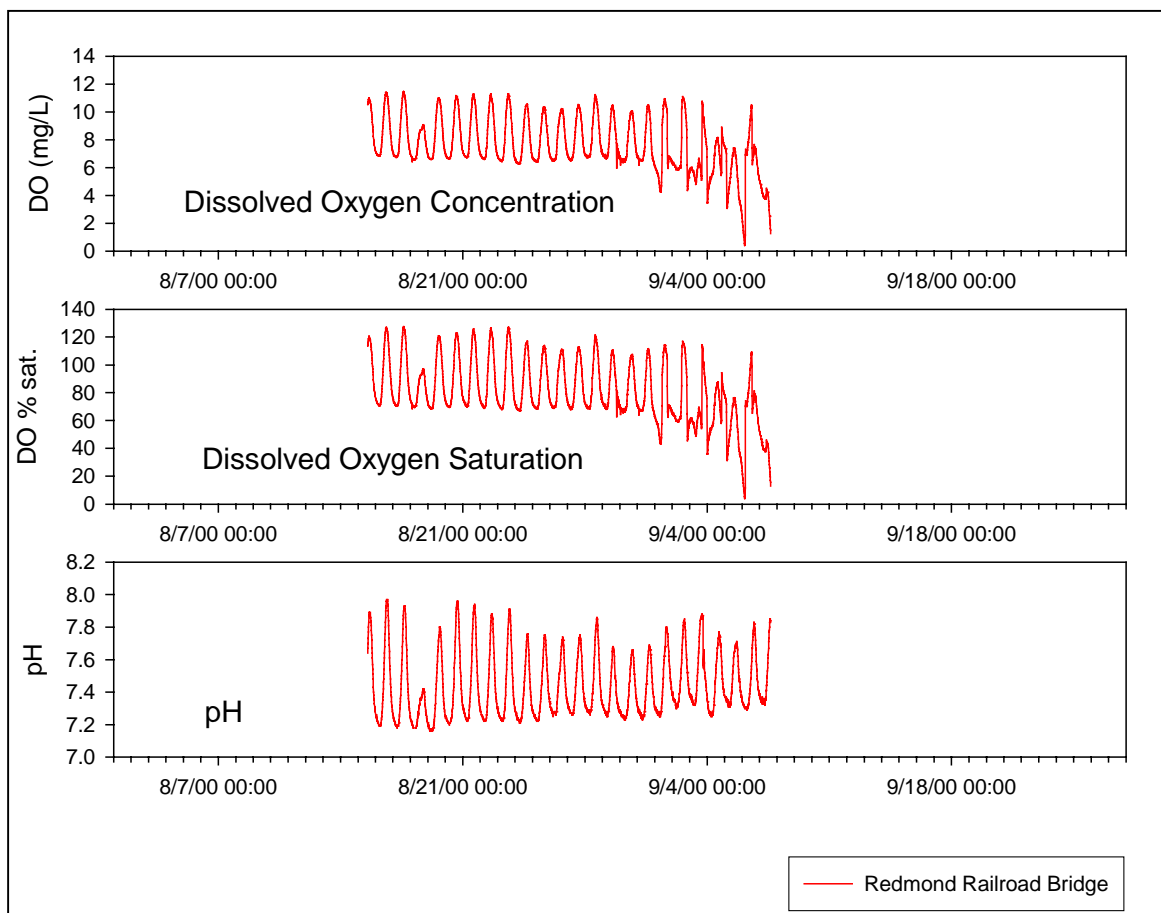


Figure 2. Sammamish River diurnal DO and pH data collected in 2000.

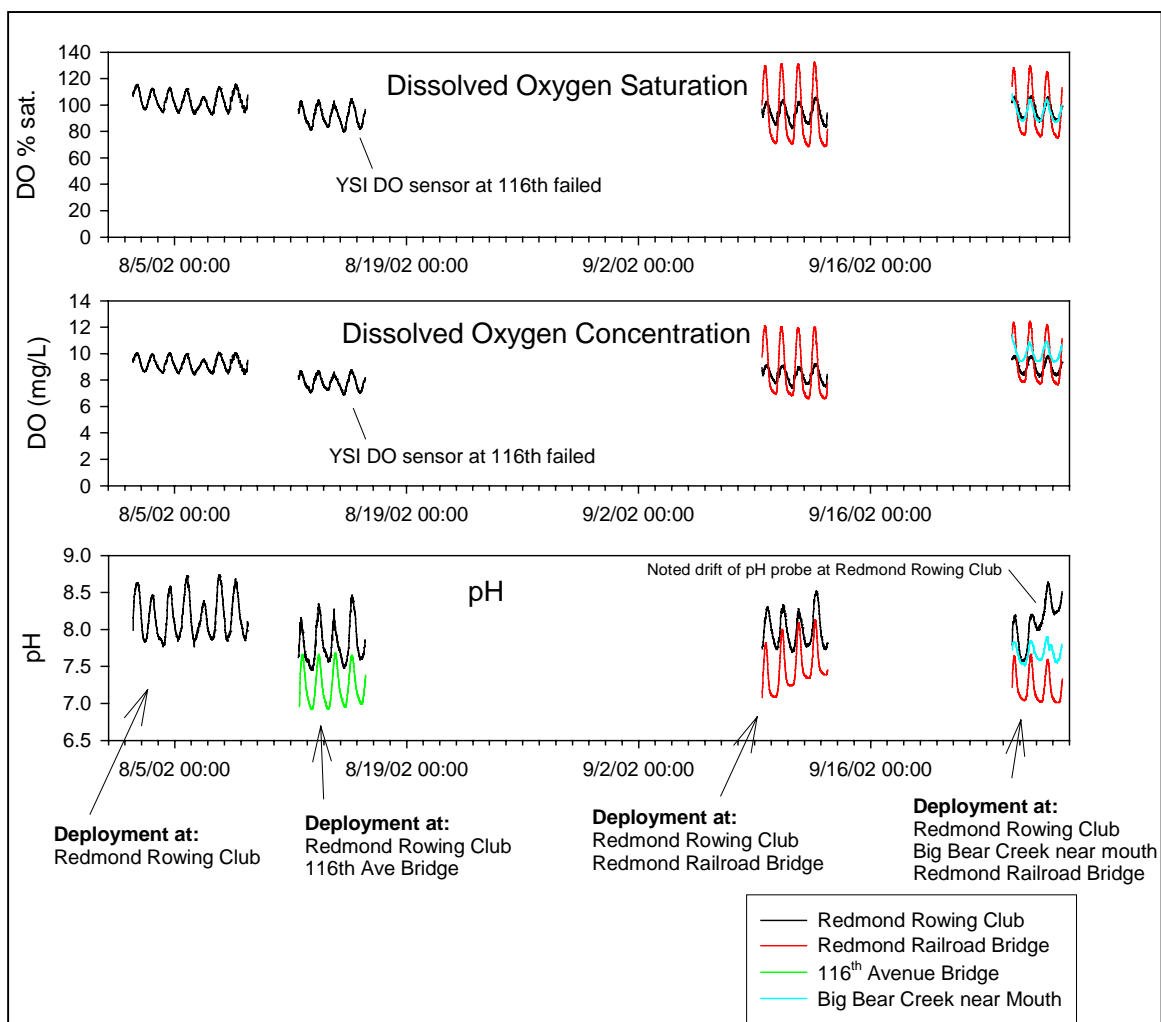


Figure 3. Sammamish River diurnal DO and pH data collected in 2002.

## 2 Study Design

### 2.1 Approach

The study is designed to provide adequate spatial and temporal resolution of DO and pH along the river within the limitations of the available resources. Stations at 7 locations along the Sammamish River (including the upstream boundary) are proposed to provide longitudinal resolution of DO and pH variation. A station on Big Bear Creek near the mouth is proposed to evaluate the influence of tributary DO and pH fluctuations on the Sammamish River. Therefore, we plan to monitor 8 stations during this study. Proposed station locations are shown in Figure 4.

### 2.2 Field Study Plan

Diurnal sampling should begin in June when the river begins to warm and end in October when the chinook salmon migration is nearly complete. Sampling should be conducted simultaneously at all 8 stations for a period of 7 days (Monday-Monday or

Friday-Friday) in each month. Sampling instrumentation will consist of calibrated Yellow Springs Instruments (YSI) 6600 and 6600 Extended Deployment System (EDS) sondes capable of relatively long-term autonomous deployment and equipped with temperature, DO, pH, conductivity and possibly turbidity and/or total chlorophyll probes. Sondes will be attached to shore by a stainless steel cable and anchored near the center of the channel using a small weight. The sonde probes will be suspended above the bottom by attaching a small float to the sonde's probe guard. The sondes will undergo pre- and post-calibration checks according to the current King County Environmental Laboratory (KCEL) Standard Operating Procedures (SOP) for these instruments (KCEL 2002).

Three YSI 6600 EDS sondes will be used to continuously monitor temperature, DO and pH at 3 locations along the river (see Figure 4). These locations are the upstream boundary at the Redmond Rowing Club, below the confluence with Big Bear Creek at the Redmond Railroad Bridge, and just above the confluence of Little Bear Creek at the Woodinville Railroad Bridge. An additional 6 YSI 6600 sondes will be deployed for one week each month in June through October at 5 locations (see Figure 4). These locations include Big Bear Creek, 116<sup>th</sup> Bridge, 145<sup>th</sup> Bridge, I-405 overpass and the railroad bridge near Blyth Park. Because of the stratified conditions that have been observed in the Sammamish River below North Creek (DeGasperi 2001), 2 sondes will be deployed near Blyth Park to monitor near surface and near bottom fluctuations in temperature, DO, and pH.

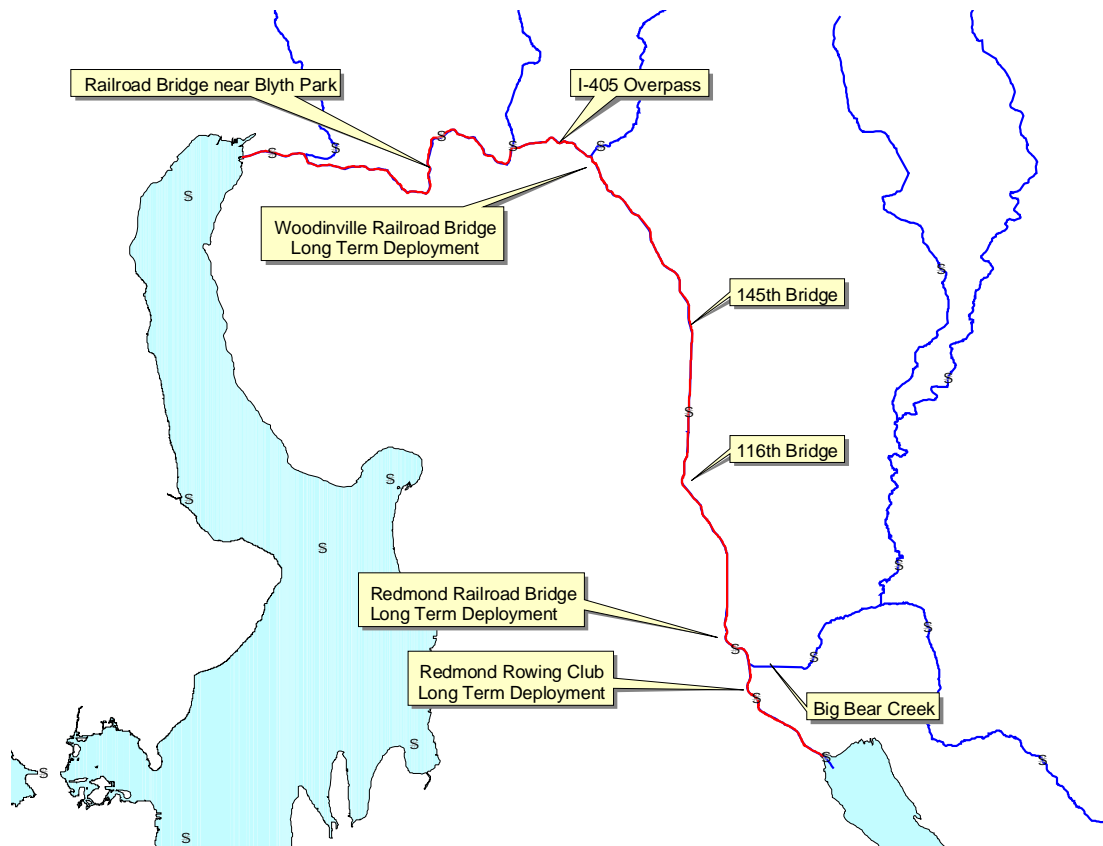


Figure 4. Proposed Sammamish River diurnal DO and pH data collection locations.

### **2.3 Laboratory Analyses**

No laboratory analyses will be required for this study.

### **2.4 Data Review, Reporting, and Management**

Data will be downloaded following each deployment and evaluated visually to identify spurious data associated with initial deployment and retrieval or sensor fouling during deployment. Post calibration checks will also be used to evaluate sensor reliability. Initially, the reviewed data will be associated with a station identifier code and compiled in an Access database for reporting and management.

### **2.5 Timeline**

This sampling plan will be implemented in June 2003. Sampling will continue through October 2003. Data review and analysis will be ongoing and will continue after sampling is completed. A brief summary report will be prepared prior to the end of 2003.

## **3 PROJECT ORGANIZATION**

Project team members and their responsibilities are summarized in Table 1. All team members are staff of the King County Department of Natural Resources and Parks.

**Table 1. Project Team Members and Responsibilities**

<b>Name/Telephone</b>	<b>Title</b>	<b>Affiliation</b>	<b>Responsibility</b>
Curtis DeGasperi (206) 296-8252	Water Quality Engineer	Wastewater Treatment Division	Project manager for the Sammamish River Diurnal DO and pH Study.
Doug Houck (206) 684-1235	Sr. Water Quality Engineer	Wastewater Treatment Division	Technical oversight for sampling activities, field QA/QC, and field analyses.
Jean Power (206) 684-2393	Environmental Specialist	Environmental Laboratory	Coordination of analytical activities, lab QA/QC, and data reporting.
Jonathan Frodge (206) 296-8018	Senior Water Quality Planner	Modeling, Assessment, and Analysis Unit	Program Manager for SWAMP.

## **4 MEASUREMENT QUALITY OBJECTIVES**

Measurement quality objectives typically involve specifications of the required precision, accuracy, and tolerable bias of the analytical measurements. Discussion is also provided that describes the methods used to ensure that the data are representative of the population targeted for sampling, and comparable to other similar studies. Methods and procedures used to minimize the loss of usable data are also described.

#### 4.1.1.1 Precision

Data precision is the degree of agreement among repeated measurements on the same sample (laboratory replicate) or on separate samples collected as close as possible temporally and spatially (field replicate). A measure of precision gives one an idea of how consistent and reproducible your field or laboratory methods are. However, precision does not reflect how “true” or accurate the results are. Typically, precision is monitored by the analysis of replicate field or laboratory samples. However, electronic instrumentation is typically designed and tested to reliably measure specific parameters with a stated precision. The stated precision of the YSI sondes for the target parameters is shown in Table 2.

#### 4.1.1.2 Accuracy and bias

Accuracy is a measure of confidence in the analytical results. The smaller the difference between the measurement and the “true” value, the more accurate the results. The pattern of these differences (typically higher or lower) indicates the amount of bias in the results. Results with high precision and low bias are more accurate than results with high bias and precision or high bias and low precision. Results may still be accurate if they have low bias and precision, but there will tend to be a random scatter of replicate results around the true value. Because we plan to record a single value at each time interval to represent the “true” concentration of DO and pH, it is important that our results have low bias and high precision.

Following standard protocols for the maintenance and calibration of the YSI instruments will ensure the accuracy and minimize bias of the data.

**Table 2. Reported YSI 6600 Probe Accuracy, Precision, and Bias**

Parameter	Accuracy	Precision	Range
Temperature, °C	±0.15°C	0.01°C	-5 - +45 °C
Dissolved Oxygen, mg/L	±2% or 0.2 mg/L <sup>a</sup>	0.01 mg/L	0 - 20 mg/L
Dissolved Oxygen, % Saturation	±2% or 2% air saturation <sup>a</sup>	0.1%	0 - 200%
pH, log[H <sup>+</sup> ]	±0.2	0.01	0 - 14
Conductivity, mS/cm <sup>b</sup>	± 5% + 0.001 mS/cm	0.001 to 0.1 mS/cm <sup>c</sup>	0 - 100 mS/cm
Turbidity, NTU	±5% or 2 NTU <sup>a</sup>	0.1 NTU	0 - 1000 NTU
Total Chlorophyll, µg/L [Fluorescence, % FS]	NA <sup>d</sup>	0.1 µg/L, 0.1% FS	0 - 400 µg/L, 0 – 100% FS

% FS = Percent of full scale  
NA = Not available  
<sup>a</sup> Whichever value is higher.  
<sup>b</sup> Conductivity will be converted by the sonde software and reported as specific conductance (conductivity corrected to 25°C) based on the equation found in Standard Methods (APHA 1998).  
<sup>c</sup> Precision is range dependent.  
<sup>d</sup> The accuracy of the chlorophyll probe is not provided. Accuracy of chlorophyll measurements depends on specific calibration methods used and the environmental conditions in which measurements are made.

#### 4.1.1.3 Representativeness

Representativeness is the extent to which measurements actually depict the true population under evaluation.

Field sampling techniques proposed for this study should provide data that are representative of diurnal changes in DO concentrations and pH in the main channel of the river and tributaries. Critical elements in the collection of representative data include placing the sonde near the center of the channel and in the main flow, suspending the sonde probes above the bottom and ensuring that the probes are submerged below the water surface during each deployment.

#### 4.1.1.4 Comparability

Comparability is the extent to which data from one study can be compared directly to either historical data or data being collected in another project.

The objective of this study is not to provide data that are comparable to historical DO and pH data. However, measures described above to evaluate the quality of the data should provide supporting information that may be used to assess the suitability of the data for comparison to historical information or data collected currently by other investigators.

#### 4.1.1.5 Completeness

Completeness is a measure of the number of samples you must take to be able to use the information, as compared to the number of samples you originally planned to take.

Ideally, implementation of this plan will result in collection of usable data for each proposed instrument deployment. Generally, instrument deployment and data management experience of the involved personnel should ensure that each deployment will be successful. However, where data are not complete, decisions regarding re-sampling will be made by a collaborative process involving both data users and data generators.

## **5 MEASUREMENT AND SAMPLING PROCEDURES**

Field sampling and measurement protocols will follow those described above in Section 2.2 Field Study Plan and in the KCEL SOP for Unattended YSI Multiprobe Operation (SOP # 02-01-008-000).

## **6 QUALITY CONTROL PROCEDURES**

Quality control procedures will follow those described in the KCEL SOP for Unattended YSI Multiprobe Operation (SOP # 02-01-008-000).

## **7 DATA ANALYSIS AND MODELING PROCEDURES**

Data will be compared to simulated water quality data from the Sammamish River water quality model. The data may also be used to evaluate water quality in reference to relevant existing or proposed state water quality standards.

## **8 PROJECT DELIVERABLES**

Summary report in hardcopy and electronic format and database in electronic format as identified above.

### **8.1 Timeline**

Data and associated finalized prior to the end of 2003.

## **9 REFERENCES**

American Public Health Association. 1998. Standard Methods for the Examination of Water and Wastewater. 20<sup>th</sup> Edition.

DeGasperi, C. 7 November 2001. Brief Summary of the August 2001 Temperature Reconnaissance Study of the lower Sammamish River. Draft Technical Memo to Bob Swarner, King County DNR&P, Wastewater Treatment Division, Seattle, WA.

KCEL. 2002. Standard Operating Procedure for Unattended SI Multiprobe Operation (SP #: 02-01-008-000). Approved 1/23/2002.